

CLAIMS

What is claimed is:

1. A multi-layer structure comprising:
a substrate; and
a transformation layer formed on the substrate,
wherein a volume of a portion of the transformation layer irradiated by a laser beam changes when a temperature of the portion exceeds a predetermined temperature.
2. The multi-layer structure of claim 1, wherein the substrate is made from glass (SiO_2) or polycarbonate.
3. The multi-layer structure of claim 1, wherein the transformation layer comprises an alloy dielectric layer made of alloy and dielectric material.
4. The multi-layer structure of claim 3, wherein the alloy contains a rare-earth metal and a transition metal.
5. The multi-layer structure of claim 3, wherein the alloy dielectric layer is made from an alloy and a dielectric material whose volumes change due to interdiffusion or chemical change resulting from heating.
6. The multi-layer structure of claim 3, wherein the transformation layer further comprises a dielectric layer sandwiched between the substrate and the alloy dielectric layer.
7. The multi-layer of claim 3, wherein the dielectric material is ZnS-SiO_2 .
8. The multi-layer of claim 3, wherein the alloy is TbFeCo .
9. The multi-layer of claim 3, wherein the alloy is NdFeCo .

10. The multi-layer structure of claim 1, wherein the transformation layer comprises a metal oxide layer.

11. The multi-layer structure of claim 10, wherein the metal oxide layer contains a transition metal or a noble metal.

12. The multi-layer structure of claim 10, wherein the metal oxide layer is made from a material whose volume changes by releasing oxygen when heated.

13. The multi-layer structure of claim 10, wherein the transformation layer further comprises a dielectric layer sandwiched between the substrate and the metal oxide layer.

14. The multi-layer structure of claim 13, wherein the dielectric layer is made from ZnS-SiO₂

15. The multi-layer structure of claim 13, wherein the metal oxide layer is made of WO_x.

16. The multi-layer structure of claim 13, wherein the metal oxide layer has a thickness of about 80 nm.

17. The multi-layer structure of claim 1, wherein the transformation layer comprises:
a first dielectric layer formed on the substrate;
an alloy layer overlying the first dielectric layer; and
a second dielectric layer overlying the alloy layer.

18. The multi-layer structure of claim 17, wherein the first dielectric layer is made from a mixture of zinc sulfide (ZnS) and silicon dioxide (SiO₂).

19. The multi-layer structure of claim 17, wherein the first dielectric layer has a thickness of about 50 to 250 nm.

20. The multi-layer structure of claim 17, wherein the alloy layer has a thickness of about 5 to 50 nm.

21. The multi-layer structure of claim 17, wherein the alloy layer contains a rare-earth metal and a transition metal.

22. The multi-layer structure of claim 21, wherein the rare earth metal is terbium (Tb) or neodymium (Nd), and the transition metal is iron (Fe) or cobalt (Co).

23. The multi-layer structure of claim 17, wherein the alloy layer is made from a material that changes volumes of the alloy layer and the first and second dielectric layers by causing interdiffusion or chemical change with the first and second dielectric layers upon heating.

24. The multi-layer structure of claim 23, wherein the alloy layer is made from terbium-iron-cobalt (TbFeCo).

25. The multi-layer structure of claim 23, wherein the alloy layer is made from neodymium-iron-cobalt (NdFeCo).

26. The multi-layer structure of claim 17, wherein the second dielectric layer is made from a mixture of zinc sulfide (ZnS) and silicon dioxide (SiO₂).

27. The multi-layer structure of claim 17, wherein the second dielectric layer has a thickness of about 10 to 100 nm.

28. The multi-layer structure of claim 1, wherein the transformation layer comprises:
a first dielectric layer formed on the substrate;
a metal oxide layer overlying the first dielectric layer; and
a second dielectric layer overlying the metal oxide layer.

29. The multi-layer structure of claim 28, wherein the metal oxide layer contains a transition metal or a noble metal.

30. The multi-layer structure of claim 29, wherein the noble metal is one of platinum oxide (PtO_x), silver oxide (AgO_x), palladium oxide (PdO_x), and tungsten oxide (WO_x).

31. The multi-layer structure of claim 28, wherein the metal oxide layer is made from a material whose volume changes by releasing oxygen when heated.

32. A method of drawing a microscopic structure on a multi-layer structure including a substrate and a transformation layer formed on the substrate, wherein a volume of a predetermined region of the transformation layer irradiated by a laser beam changes when a temperature of the region exceeds a predetermined temperature, the method comprising:
emitting the laser beam onto the predetermined region of the transformation layer; and
heating the region of the transformation layer irradiated by the laser beam beyond the predetermined temperature,
wherein the heated region undergoes the volume change.

33. The method of claim 32, wherein the transformation layer comprises a metal oxide layer.

34. The method of claim 32, wherein the transformation layer comprises:
a first dielectric layer formed on the substrate;
an alloy layer overlying the first dielectric layer; and
a second dielectric layer overlying the alloy layer.

35. The method of claim 32, wherein the transformation layer comprises:
a first dielectric layer formed on the substrate;
a metal oxide layer overlying the first dielectric layer; and
a second dielectric layer overlying the metal oxide layer.

36. The method of claim 32, further comprising etching the transformation layer using a difference in etch rate between the predetermined region and a remaining region.

37. A master for manufacturing an optical disc, the master comprising:
a substrate; and
a transformation layer formed on the substrate,
wherein a volume of a portion of the transformation layer irradiated by a laser beam changes when a temperature of the portion exceeds a predetermined temperature.

38. The master of claim 37, wherein the transformation layer comprises an alloy dielectric layer made of alloy and dielectric material.

39. The master of claim 38, wherein the alloy contains a rare-earth metal and a transition metal.

40. The master of claim 38, wherein the alloy dielectric layer is made from an alloy and a dielectric material whose volumes change due to interdiffusion or chemical change resulting from heating.

41. The master of claim 38, wherein the transformation layer further comprises a dielectric layer sandwiched between the substrate and the alloy dielectric layer.

42. The master of claim 37, wherein the transformation layer comprises a metal oxide layer.

43. The master of claim 42, wherein the metal oxide layer contains a transition metal or a noble metal.

44. The master of claim 42, wherein the metal oxide layer is made from a material whose volume changes by releasing oxygen when heated.

45. The master of claim 42, wherein the transformation layer further comprises a dielectric layer sandwiched between the substrate and the metal oxide layer.

46. The master of claim 37, wherein the transformation layer comprises:
a first dielectric layer formed on the substrate;
an alloy layer overlying the first dielectric layer; and
a second dielectric layer overlying the alloy layer.

47. The master of claim 46, wherein the alloy layer contains a rare-earth metal and a transition metal.

48. The master of claim 46, wherein the alloy layer is made from a material such that volumes of the alloy layer and the first and second dielectric layers change due to interdiffusion or chemical change resulting from heating.

49. The master of claim 37, wherein the transformation layer comprises:
a first dielectric layer formed on the substrate;
a metal oxide layer overlying the first dielectric layer; and
a second dielectric layer overlying the metal oxide layer.

50. The master of claim 49, wherein the metal oxide layer contains a transition metal or a noble metal.

51. The master of claim 49, wherein the metal oxide layer is made from a material whose volume changes by releasing oxygen when heated.

52. A method of manufacturing a master including a substrate and a transformation layer formed on the substrate, wherein a volume of a predetermined region of the transformation layer irradiated by a laser beam changes when a temperature of the predetermined region exceeds a predetermined temperature, the method comprising:
emitting the laser beam onto the predetermined region of the transformation layer; and
heating the region of the transformation layer irradiated by the laser beam beyond the predetermined temperature,
wherein the heated region undergoes the volume change.

53. The method of claim 52, wherein the transformation layer comprises a metal oxide layer.

54. The method of claim 52, wherein the transformation layer comprises:
a first dielectric layer formed on the substrate;
an alloy layer overlying the first dielectric layer; and
a second dielectric layer overlying the alloy layer.

55. The method of claim 52, wherein the transformation layer comprises:
a first dielectric layer formed on the substrate;

a metal oxide layer overlying the first dielectric layer; and
a second dielectric layer overlying the metal oxide layer.

56. The method of claim 52, further comprising etching the transformation layer using a difference in etch rate between the predetermined region and a remaining region.

57. A computer readable medium encoded with processing instructions for performing a method of drawing a microscopic structure on a multi-layer structure including a substrate and a transformation layer formed on the substrate, wherein a volume of a predetermined region of the transformation layer irradiated by a laser beam changes when the temperature of the region exceeds a predetermined temperature, the method comprising:
emitting the laser beam onto the predetermined region of the transformation layer; and
heating the region of the transformation layer irradiated by the laser beam beyond the predetermined temperature,
wherein the heated region undergoes the volume change.

58. The computer readable medium of claim 57, wherein the transformation layer comprises:
a first dielectric layer formed on the substrate;
an alloy layer overlying the first dielectric layer; and
a second dielectric layer overlying the alloy layer.

59. The computer readable medium of claim 57, wherein the transformation layer comprises:
a first dielectric layer formed on the substrate;
a metal oxide layer overlying the first dielectric layer; and
a second dielectric layer overlying the metal oxide layer.

60. The computer readable medium of claim 57, further comprising etching the transformation layer using a difference in etch rate between the predetermined region and the remaining region.

61. A computer readable medium encoded with processing instructions for performing a method of manufacturing a master including a substrate and a transformation layer formed on the substrate, wherein a volume of a predetermined region of the transformation layer irradiated by a laser beam changes when a temperature of the predetermined region exceeds a predetermined temperature, the method comprising:

emitting the laser beam onto the predetermined region of the transformation layer; and
heating the region of the transformation layer irradiated by the laser beam beyond the predetermined temperature,

wherein the heated region undergoes the volume change.

62. A method of drawing a microscopic structure on a multi-layer structure including a substrate and a transformation layer formed on the substrate, wherein a volume of a predetermined region of the transformation layer irradiated by a laser beam changes when a temperature of the region exceeds a predetermined temperature, the method comprising:

emitting the laser beam onto the predetermined region of the transformation layer; and
heating the region of the transformation layer irradiated by the laser beam beyond the predetermined temperature,

wherein a diameter of the heated region is smaller than a diameter of the laser beam thus forming a pit with a diameter smaller than that of a laser beam spot.

63. A method of drawing a microscopic structure on a multi-layer structure including a substrate and a transformation layer formed on the substrate, wherein a volume of a predetermined region of the transformation layer irradiated by a laser beam changes when a temperature of the region exceeds a predetermined temperature, the method comprising:

emitting the laser beam onto the predetermined region of the transformation layer; and
heating the region of the transformation layer irradiated by the laser beam beyond the predetermined temperature,

wherein a pit pattern with a size smaller than a diffraction limit of the laser beam is formed on the multi-layer structure.

64. The multi-layer structure of claim 17, wherein the first dielectric layer, the alloy layer and the second dielectric layer are combined into a single structure.

65. The multi-layer structure of claim 10, wherein the metal oxide layer is formed directly on the substrate.

66. The method of claim 32, further comprising:
injection-molding a polycarbonate optical disc substrate in an injection-molding apparatus and sequentially coating a reflective layer and a protective layer over the injection-molded substrate.

67. The method of claim 32, wherein microscopic pits having a size smaller than a diffraction limit of the laser beam are created, without requiring a large light source or causing the deformation or evaporation of a resist material due to elevated temperature.

68. A method of forming a pit pattern on a multi-layer structure including a substrate and a transformation layer formed on the substrate, the method comprising:
changing a volume of a predetermined region of the transformation layer by irradiating a laser beam onto the predetermined region of the transformation layer; and
forming the pit pattern on the multi-layer structure, the pit pattern having a size smaller than a diffraction limit of the laser beam.

69. The method of claim 68, wherein the volume of the predetermined region changes by heating the predetermined region beyond a predetermined temperature.

70. An apparatus forming optical discs, the apparatus comprising:
a stamper molding an optical disc substrate, the stamper having a pit pattern smaller than a diffraction limit of a laser beam used to form the pit pattern; and
a coater coating a reflective layer and a protective layer over the molded optical disc substrate.